[0023] FIG. **15** is a diagram of an illustrative hologram recording system for recording reflection hologram structures in accordance with some embodiments.

[0024] FIG. **16** is a diagram of an illustrative display system having a multi-layer holographic combiner provided with optical power that varies as a function of eye box position to compensate for aberrations produced by the optical components of the display system in accordance with some embodiments.

[0025] FIG. **17** is a diagram of an illustrative hologram recording system for recording reflection holograms that are provided with varying optical power to compensate for aberrations produced by the optical components of a display system in accordance with some embodiments.

[0026] FIG. **18** is a diagram of an illustrative system having an image sensor for performing feedback adjustments on a projector that illuminates a multi-layer holographic combiner to mitigate changes in relative position between the projector and the multi-layer holographic combiner over time in accordance with some embodiments.

[0027] FIG. **19** is a flow chart of illustrative steps involved in performing feedback adjustments on a projector that illuminates a multi-layer holographic combiner to mitigate changes in relative position between the projector and the multi-layer holographic combiner over time in accordance with some embodiments.

[0028] FIG. **20** is a diagram of an illustrative optical system having a waveguide for expanding the pupil for a multi-layer holographic combiner in accordance with some embodiments.

[0029] FIG. **21** is a diagram of an illustrative multi-layer optical combiner having multiple transmission hologram structures in accordance with some embodiments.

DETAILED DESCRIPTION

[0030] An illustrative system having a device with one or more near-eye display systems is shown in FIG. **1**. System **10** may be a head-mounted device having one or more displays such as near-eye displays **20** mounted within support structure (housing) **8**. Support structure **8** may have the shape of a pair of eyeglasses (e.g., supporting frames), may form a housing having a helmet shape, or may have other configurations to help in mounting and securing the components of near-eye displays **20** on the head or near the eye of a user. Near-eye displays **20** may include one or more display modules such as display modules **20**A and one or more optical systems such as optical systems **20**B. Display modules **20**A may be mounted in a support structure such as support structure **8**. Each display module **20**A may emit light **38** (image light) that is redirected towards a user's eyes at eye box **24** using an associated one of optical systems **20**B.

[0031] The operation of system **10** may be controlled using control circuitry **16**. Control circuitry **16** may include storage and processing circuitry for controlling the operation of system **10**. Circuitry **16** may include storage such as hard disk drive storage, nonvolatile memory (e.g., electrically-programmable-read-only memory configured to form a solid state drive), volatile memory (e.g., static or dynamic random-access-memory), etc. Processing circuitry in control circuitry **16** may be based on one or more microprocessors, microcontrollers, digital signal processors, baseband processors, power management units, audio chips, graphics processing units, application specific integrated circuits, and other integrated circuits. Software code may be stored on storage in circuitry **16** (e.g., non-transitory computer readable media) and run on processing circuitry in circuitry **16** to implement operations for system **10** (e.g., data gathering operations, operations involving the adjustment of components using control signals, image rendering operations to produce image content to be displayed for a user, etc.).

[0032] System **10** may include input-output circuitry such as input-output devices **12**. Input-output devices **12** may be used to allow data to be received by system **10** from external equipment (e.g., a tethered computer, a portable device such as a handheld device or laptop computer, or other electrical equipment) and to allow a user to provide head-mounted device **10** with user input. Input-output devices **12** may also be used to gather information on the environment in which system **10** (e.g., head-mounted device **10**) is operating. Output components in devices **12** may allow system **10** to provide a user with output and may be used to communicate with external electrical equipment. Input-output devices **12** may include sensors and other components **18** (e.g., image sensors for gathering images of real-world object that are digitally merged with virtual objects on a display in system **10**, accelerometers, depth sensors, light sensors, haptic output devices, speakers, batteries, wireless communications circuits for communicating between system **10** and external electronic equipment, etc.).

[0033] Display modules **20**A may include liquid crystal displays, organic light-emitting diode displays, laser-based displays, microelectromechanical system (MEMS)-based displays, digital micromirror device (DMD) displays, liquid crystal on silicon (LCoS) displays, computer-generated holography (CGH) displays, or displays of other types, as well as optical components used to support the displays. Display modules **20**A may sometimes be referred to herein as projectors **20**A. Display modules **20**A may produce (project) image light **38**. Optical systems **20**B may include lenses that allow a viewer (see, e.g., a viewer's eyes at eye box **24**) to view images on display(s) **20**. There may be two optical systems **20**B (e.g., for forming left and right lenses) associated with respective left and right eyes of the user. A single display **20** may produce images for both eyes or a pair of displays **20** may be used to display images. In configurations with multiple displays (e.g., left and right eye displays), the focal length and positions of the lenses formed by components in optical system **20**B may be selected so that any gap present between the displays will not be visible to a user (e.g., so that the images of the left and right displays overlap or merge seamlessly).

[0034] If desired, optical system **20**B may contain components (e.g., an optical combiner, etc.) to allow real-world image light **30** from real-world images or objects **28** to be combined optically with virtual (computer-generated) images such as virtual images in image light **38**. In this type of system, which is sometimes referred to as an augmented reality system, a user of system **10** may view both real-world content and computer-generated content that is overlaid on top of the real-world content. Camera-based augmented reality systems may also be used in device **10** (e.g., in an arrangement which a camera captures real-world images of object **28** and this content is digitally merged with virtual content at optical system **20**B). In one suitable arrangement that is described herein by example, the optical combiner in optical system **20**B includes a multi-layer holographic combiner.